Journal of Experimental Political Science (2025), 1–14
doi:10.1017/XPS.2025.10017

RESEARCH ARTICLE

Balanced Messaging about Solar Geoengineering does not Reduce Average Support for Emissions Reductions

Damian Antoan, Nicholas Chiang, Spencer Dearman, Santiago Espejel, Manarldeen Fajors, Darina Huang, Elliott Husseman, Justin Lavigne, Isabella Lin, Neel Maheshwari, Zidane Marinez, George Nottley, Julien Perce, Ezra Santos, Natasha Sokhi, Carlos Sole, Adam Tuchler, Jay Udinsky, Zikai Li and Andrew C. Eggers*

University of Chicago, Chicago, USA
Corresponding author: Andrew Eggers; Email: aeggers@uchicago.edu

Abstract

Solar geoengineering offers a speculative means to cool the planet by reflecting solar radiation into space. While some research suggests that awareness of solar geoengineering could reduce public support for decarbonization through a moral hazard mechanism, other studies indicate that it could serve as a "clarion call" that motivates further action. Using a pre-registered factorial design, we assess how sharing balanced information on solar geoengineering affects attitudes toward decarbonization policies and climate attitudes among 2,509 US residents. We do not find that solar geoengineering information affects support for decarbonization on average, though it may increase support among initially less supportive subgroups; moreover, this information tends to increase the perception that climate change is a daunting problem that cannot be resolved without decarbonization. Our results suggest that concerns about moral hazard should not discourage research on solar geoengineering – as long as the public encounters realistic messages about solar geoengineering's role.

Keywords: Climate change; solar geoengineering; public opinion; moral hazard; survey experiment

This article has earned badges for transparent research practices: Open Data, Open Materials, and Preregistered. For details see the Data Availability Statement.

*Eggers is a professor of political science at the University of Chicago. Li is a PhD candidate in political science at the University of Chicago. Other authors were undergraduate students in "Social Science Inquiry" at the University of Chicago in the spring of 2024. Research was supported by a grant from the University of Chicago's Climate Systems Engineering Initiative (CSEi) and by a University of Chicago Core Conversation Innovation Grant. The authors thank Molly Offer-Westort for feedback. Pre-analysis plan ("Effects of informing Americans about solar geoengineering") available at https://osf.io/ajm4x. See Appendix Table 13 for information about the correspondence between the manuscript and the pre-registration document. The University of Chicago SBS-IRB issued an exempt determination for this research (IRB23-0386-AM003). Replication data and code are available at the publisher's repository (Eggers, 2025).

Introduction

Solar geoengineering refers to a group of proposed techniques that aim to reduce global warming by reflecting a portion of sunlight away from Earth. One prominent proposal is stratospheric aerosol injection (SAI), which mimics the cooling effect of volcanic eruptions by injecting reflective aerosols such as sulfur dioxide into the upper atmosphere to scatter sunlight (National Academies of Sciences, Engineering, and Medicine 2021). Climate scientists remain unsure how a sustained program of SAI would affect the ozone layer and local weather patterns; questions also remain about the potential health and environmental effects of spraying sulfuric acid or other aerosols into the atmosphere.

As solar geoengineering research has attracted more attention, critics have raised a further, more social scientific objection: will researching or even discussing solar geoengineering undermine public support for the vital work of decarbonization?[1] If the public learns that solar geoengineering can lessen the damage from climate change, there might be a weakening of public support for taking the necessary steps to reduce the concentration of greenhouse gases in the atmosphere, exacerbating the underlying problem and some of its consequences (such as ocean acidification). Keith (2000) refers to this possibility as "moral hazard;" others refer to crowding out (Cherry et al. 2021), lack of self-control (Wagner & Weitzman 2015), or risk compensation (Lin 2013; Reynolds 2015). Even if solar geoengineering is found to be effective and safe in engineering terms, deploying it could have a net negative impact if this moral hazard mechanism operates strongly enough. In that case, decarbonization should be the sole focus, and investigation of solar geoengineering (let alone deployment) should be discouraged.

Although some previous research has validated concerns about SAI and moral hazard (Raimi et al. 2019; Campbell-Arvai et al. 2017; Andrews et al. 2022), other studies suggest that informing the public about SAI can instead serve as a "clarion call" that inspires greater support for decarbonization (Merk et al. 2016; Cherry et al. 2021), as we discuss below. Given these conflicting results and important limitations in previous work, we revisit the issue with a new study that builds on previous work while addressing some of its shortcomings. Our preregistered survey experiment assesses how exposing Americans to balanced information about solar geoengineering, either on its own or in conjunction with a message about decarbonization, affects support for mitigation policy and attitudes toward climate change. We also assess how these effects vary with respondents' political ideology, concern about global warming, and attribution of global warming to human action (all measured pre-treatment).

We find no evidence that informing Americans about SAI affects average support for emissions reductions, even compared to a message emphasizing the importance of decarbonization. We also do not find that SAI information has more positive effects for liberal respondents, but we do find suggestive evidence that it increases support for mitigation policy among respondents who are less concerned about climate change. Turning to attitudes about climate change, we find that providing balanced SAI information increases average concern about global warming (though

[1]For example, see Thompson (2021) and Hamilton (2013). The same question arises in discussions of adaptation (Lin 2013) and carbon dioxide removal (Hart et al. 2022).

https://doi.org/10.1017/XPS.2025.10017 Published online by Cambridge University Press

not when paired with the decarbonization message) and increases the perception that without emissions reductions we may end up "deploying unproven technologies with harmful consequences" to address global warming; it also decreases respondents' confidence that technology will allow us to address global warming without emissions reductions. Together, our results suggest that informing people about SAI may make climate change seem like a more challenging, higher-stakes problem, especially among those who are initially relatively complacent about climate change.

Background

Theoretical considerations and prior empirical evidence yield conflicting expectations about how sharing information about SAI and related technologies might shape public attitudes toward climate change mitigation.

The moral hazard hypothesis suggests that informing the public about SAI could lead to an unwarranted decline in public support for decarbonization. Offered a temporary means of limiting global warming, such as SAI, the public may come to view costly emissions reductions as unnecessary. Consistent with this moral hazard hypothesis, Raimi et al. (2019) found that reading a highly optimistic description of SAI could make Americans less supportive of policies that would reduce carbon emissions. Similarly, Campbell-Arvai et al. (2017) report that learning about carbon dioxide removal may reduce support for emissions reductions by diminishing the perceived threat of climate change.[2] Andrews et al. (2022) find via incentivized games that subjects who are asked to make policy decisions expect others to engage in moral hazard behavior, discouraging the deployment of geoengineering technologies. Considering that SAI experts view SAI as a complement to aggressive emissions reductions (Keith 2021; National Academies of Sciences, Engineering, and Medicine 2021), it is important to assess this moral hazard mechanism as one of the possible harmful unintended consequences of further research into SAI.

SAI information could have the opposite effect, however, increasing the desire to reduce emissions. As Merk et al. (2016) noted, learning about SAI could act as a "clarion call." The knowledge that experts are seriously considering spraying sulfuric acid into the atmosphere to block the sun's rays could reinforce the belief that climate change is a serious problem. To the extent that SAI sounds like a risky technology that should be avoided, information about SAI may also make recipients more committed to reducing emissions as a way of making sure that SAI is never attempted. Consistent with this, Merk et al. (2016) found that providing information on SAI increased German survey respondents' average willingness to pay for carbon offsets. Similarly, in a US sample, Cherry et al. (2021) found that providing information about solar geoengineering increased support for a carbon tax among respondents with egalitarian and communitarian worldviews.

Of course, SAI information could also have little average effect on attitudes toward decarbonization, whether because these attitudes are relatively fixed or because such information provokes a mix of conflicting reactions. Indeed, most

[2]This result comes from a mediation analysis that relies on strong assumptions; the reported effect of information on policy support is not statistically significant.

https://doi.org/10.1017/XPS.2025.10017 Published online by Cambridge University Press

recent studies appear to show minimal impacts of geoengineering information. In a US sample, Schoenegger & Mintz-Woo (2024) found that providing solar geoengineering information had no significant effect on support for emissions reductions measured by either behavioral choices or stated preferences. Similarly, Fairbrother (2016) found that solar geoengineering information does not significantly impact trust in climate science or willingness to pay taxes on polluting energy in a UK sample, and Merk & Wagner (2024) found no effect of including solar geoengineering information in appeals for climate action on Facebook, except when in conjunction with extreme messaging. Austin & Converse (2021) found no significant effect of reading a news article about solar geoengineering on commitment to mitigation efforts in a US sample, and Andrews et al. (2022) also report no evidence of moral hazard among participants.[3]

Our contribution

Our research seeks to contribute to the existing literature on the effects of SAI information in three principal ways.

First, while other studies (Merk et al. 2016; Fairbrother 2016; Cherry et al. 2021; Schoenegger & Mintz-Woo 2024) examine the effect of providing SAI information in isolation, we use a factorial design that allows us to compare the effect of providing SAI information to the effect of providing a decarbonization message and to compare the effect of providing SAI information on its own to the effect of providing both messages. Critics of SAI (e.g., Thompson 2021; Vasquez 2021) stress that we should keep a laser focus on decarbonization, while SAI researchers describe SAI as a possible complement to deep decarbonization (e.g., Keith 2021; National Academies of Sciences, Engineering, and Medicine 2021). Our design allows us to compare the effects of SAI information on its own, a decarbonization message on its own, and a combined message.

Second, while previous studies (particularly Raimi et al. 2019; Merk & Wagner 2024) measured the effects of framing SAI in exaggeratedly positive or negative terms,[4] we focus on reactions to a neutral, balanced presentation of both SAI and decarbonization. Raimi et al. (2019) established that describing SAI in highly optimistic terms (suggesting "we wouldn't have to do much more" to mitigate climate change) could reduce support for decarbonization among Americans; a more moderate framing in the same study did not produce such an effect. Building on this more moderate framing (and similar to the framing in Schoenegger & Mintz-Woo (2024)), we present SAI much as it is presented by SAI experts (Keith 2021) – as a potentially effective medium-term measure with acknowledged risks. Distinct from Raimi et al. (2019)'s framings, our framing refrains from explicitly depicting SAI as either a substitute or a complement to emissions reductions, thus leaving it to respondents to draw their own conclusions about the implications of SAI for decarbonization efforts.

[3]Hart et al. (2022) and Sloot & Bostrom (2024) also show minimal effects of information about carbon dioxide removal on support for emissions reductions.

[4]In Wenger et al. (2021), Swiss respondents are skeptical of the idea that geoengineering could make emissions reductions unnecessary.

https://doi.org/10.1017/XPS.2025.10017 Published online by Cambridge University Press

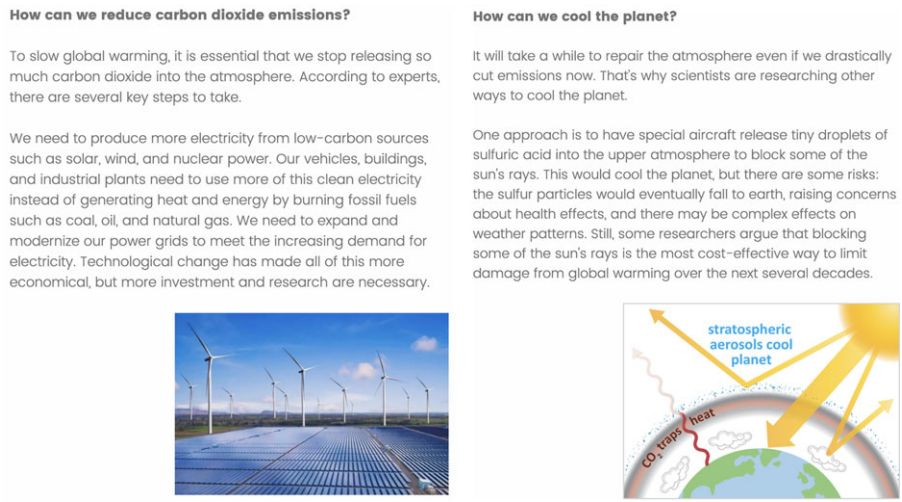

Figure 1. Treatments shown to survey participants: Decarbonization (left) and SAI (right).

Third, we take important steps to advance the scientific rigor of studies on this topic. To our knowledge, ours is the first study on the effects of SAI information to be pre-registered, and after Raimi et al. (2019), it will be the second to make its data publicly available on publication. Moreover, in two important studies in this literature (Merk et al. 2016; Cherry et al. 2021), the main regression analyses adjust for post-treatment variables, which could undermine the randomization and produce biased results (Montgomery et al. 2018). By contrast, all control variables and moderators in our analysis are measured before treatment is applied.

Survey design

In this section, we explain the design of our survey. The exact questions appear in the Appendix.

Treatments

All respondents were shown a screen explaining how carbon emissions contribute to global warming (see Figure 2 in the Appendix). Our message combines a "blanket metaphor" explanation of the greenhouse effect (from Bergquist et al. (2022)) with a statement that past carbon emissions will continue to warm the planet for hundreds or even thousands of years (derived from Keith (2021), who calls this "the single most important fact about climate change").

Respondents were then randomly assigned into one of four groups: (1) Control; (2) Decarbonization; (3) SAI; (4) Both. Respondents in the control group were not given any additional information. The decarbonization group was shown the message at left in Figure 1. It states that reducing emissions is essential, lists "key steps to take," and shows an image of solar panels and wind turbines. The SAI group was shown the message at right in Figure 1. It states that emissions reductions will

https://doi.org/10.1017/XPS.2025.10017 Published online by Cambridge University Press

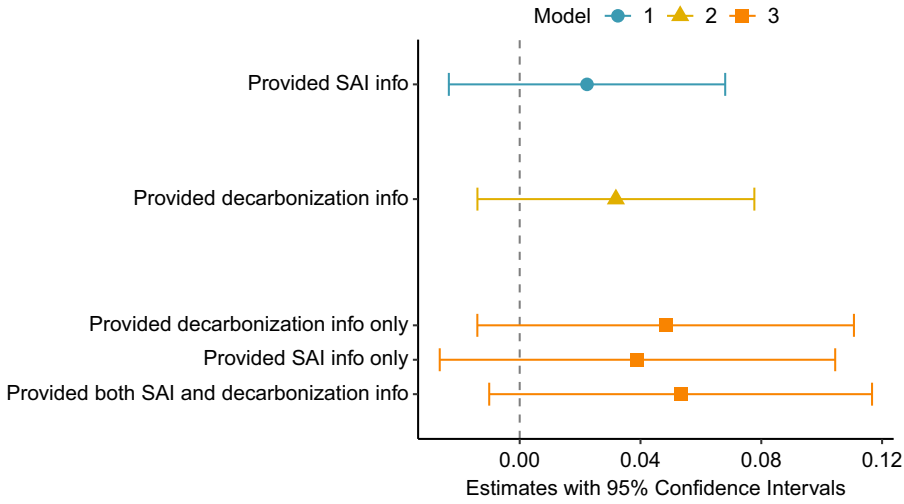

Figure 2. Effect of information treatments on support for emission reduction policies.

not immediately repair the atmosphere, so "scientists are researching other ways to cool the planet." It then describes SAI and some of its risks and benefits, accompanied by a diagram showing sunlight being reflected into space by stratospheric aerosols. Respondents in the Both group saw the decarbonization information followed by the SAI information.[5]

Outcome measures

To measure support for a range of emissions reduction policies, we ask our respondents to assess eight possible US climate policies drawn from Raimi et al. (2019) (international emissions treaty, stricter fuel efficiency standards, subsidies to renewable energy, a carbon tax, expanded nuclear power, energy conservation regulations, industrial emissions reductions, and clean energy research subsidies) at the very end of the survey. We convert support for each measure to a numerical 1-5 scale and average them to obtain an index of post-treatment support for emissions reduction policy.

To assess mechanisms by which SAI information could affect policy preferences, we asked additional questions after treatment but before the policy questions.[6] To tap into the "clarion call" mechanism highlighted by Merk et al. (2016), we asked respondents to state how much (five points between "Not at all" and "A great deal") they think global warming will affect them personally and how much it will negatively affect future generations. We convert the two responses to a numerical 1-5 scale and average them to obtain an index of post-treatment global warming concern.

[5]Presented in this order, the Both treatment roughly mirrors Keith (2021)'s argument in favor of SAI research. Respondents in the Both condition see more text than those in SAI or Decarbonization, and those in Control see less.

[6]These questions raise the salience of particular concerns (e.g., the fate of future generations, risks from unproven technologies), which may moderate the effect of SAI information on policy support given that our policy questions appear at the end of the survey.

https://doi.org/10.1017/XPS.2025.10017 Published online by Cambridge University Press

To assess other mechanisms through which SAI information might affect policy preferences, we surveyed respondents' agreement with each of the following statements:

1. Techno-threat: "If we don't take action to reduce emissions now, then responding to global warming in the future is likely to require deploying unproven technologies with harmful consequences." (SAI information could make salient a threat that respondents would seek to avoid, as suggested by Merk et al. (2016).)

2. Belief in the efficacy of emissions reductions: "Humanity could limit future increases in the global average temperature by reducing emissions of carbon dioxide now." (SAI information could strengthen respondents' understanding of and belief in the greenhouse effect.)

3. Techno-fix: "Thanks to technology, there is a good chance that we will be able to completely solve the problem of global warming in the next 50 years without significantly reducing carbon dioxide emissions." (SAI information could convince respondents that technology will solve climate change without the need for emissions reductions.)

Pre-treatment covariates

At the start of the survey, we asked respondents to assess their political ideology on a five-point scale from "Very liberal" to "Very conservative." After reading our explanation of global warming but before seeing any treatment messages, all respondents were also asked how concerned they were about global warming, how much of global warming they think is caused by human activities, and whether they believe that they can "do something to address global warming." All four pre-treatment questions were used as categorical prognostic covariates in regression analysis, as explained below.

Sample

We fielded our survey to 2,509[7] US residents[8] on April 30, 2024, using CloudResearch Connect, an online survey panel. To counteract typical biases in internet panels, we specified quotas to obtain a 50-50 gender split and a 30-30-40 split between respondents who identify as Democrats, Republicans, and other (Independents, something else, prefer not to say).

Our pre-analysis plan stated that we would exclude respondents who completed the survey unusually quickly or slowly, conditional on treatment status (a total of 32 respondents), as well as those who missed an attention check question (an additional 139 respondents), given a satisfactory balance in the post-exclusion sample. To allay concerns about post-treatment bias caused by these exclusions (and to meet the journal's submission guidelines), we deviate from this plan and report

[7]The sample size was determined by our survey budget and guided by a priori power calculations, which indicated we would have sufficient power (above 0.8) to detect an effect of 0.15 of a standard deviation in the outcome variable (see Appendix Section 2 for more details).

[8]We study the US because it will likely have an important role in solar geoengineering, but similar research in other populations is important given solar geoengineering's global scope (e.g., Sugiyama et al. 2020).

https://doi.org/10.1017/XPS.2025.10017 Published online by Cambridge University Press

results for the full sample in the main text; all pre-registered results using the restricted sample appear in the Appendix (along with balance tests). The two sets of results are substantively identical.[9]

Our sample is broadly representative of the US in terms of gender, partisanship, and race. It is younger than the population (with e.g., about 32% of respondents in their thirties, compared to around 18% of the population, and 3% of respondents over 70, compared to 15% of the population); it is also more educated, with about 40% holding BAs compared to about 22% of the population, and its distribution of household income is lower than that in the population. (See Appendix Figure 3 for further details on representativeness.)

Results

In all analysis, we use OLS regression with heteroskedasticity-robust (HC2) standard errors. Analysis of pilot data showed that all four pre-treatment variables (ideology, concern about global warming, attribution of global warming, and self-efficacy) predict support for climate mitigation policy, so following our pre-analysis plan, we include all four variables as prognostic covariates. Also, following our pre-analysis plan, we standardize all outcome variables so that all treatment effects are measured in standard deviations of the outcome variable.

Manipulation check

We expected that few respondents would be familiar with SAI and that the SAI information we provide would therefore substantially increase awareness of SAI. To check this, we asked respondents to indicate whether each of four technologies is viewed by some experts as a promising response to global warming. Two of the listed technologies are fanciful ("Pumping dry ice into the earth's crust" and "Extracting silicates from agricultural soil"), while one describes SAI ("Releasing sulfur dioxide into the stratosphere") and one is a component of decarbonization ("Converting heating systems to use electricity instead of gas"). Consistent with expectations, we find that about 70% of respondents who receive the SAI information indicate that "releasing sulfur dioxide into the stratosphere" is considered promising by some experts, compared to only about 20% of respondents who did not receive this information. By contrast, we do not find an effect of providing the decarbonization treatment on respondents' recognition that electrifying heating systems is seen as promising. (Full results appear in Appendix Figure 4 and Table 1.) This suggests that (i) our respondents were mostly unaware of SAI before the experiment, (ii) many of those who received SAI information became aware of the technology as a result, and (iii) awareness of decarbonization/electrification is higher at baseline and was unaffected by our information treatments.

[9]Some marginally significant results become marginally insignificant and vice versa, but the point estimates are very similar.

https://doi.org/10.1017/XPS.2025.10017 Published online by Cambridge University Press

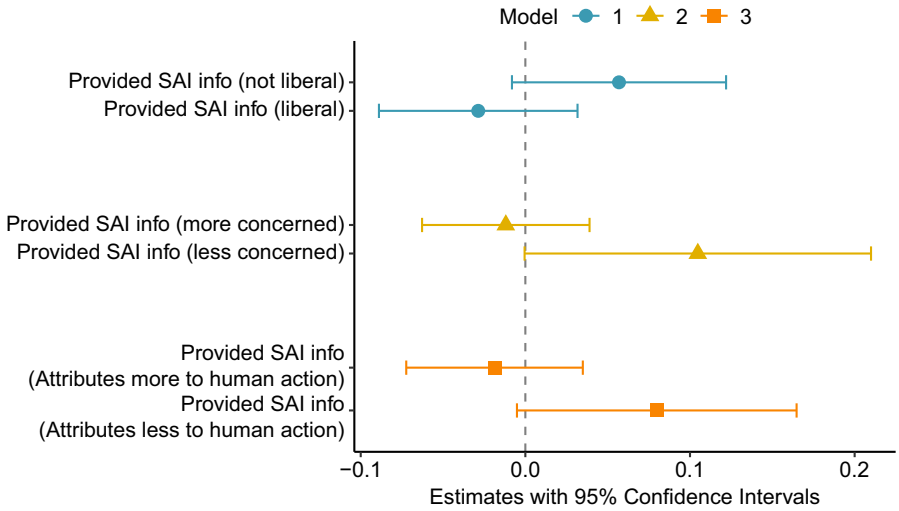

Figure 3. Heterogeneity in the effect of SAI information on support for emission reduction policies.

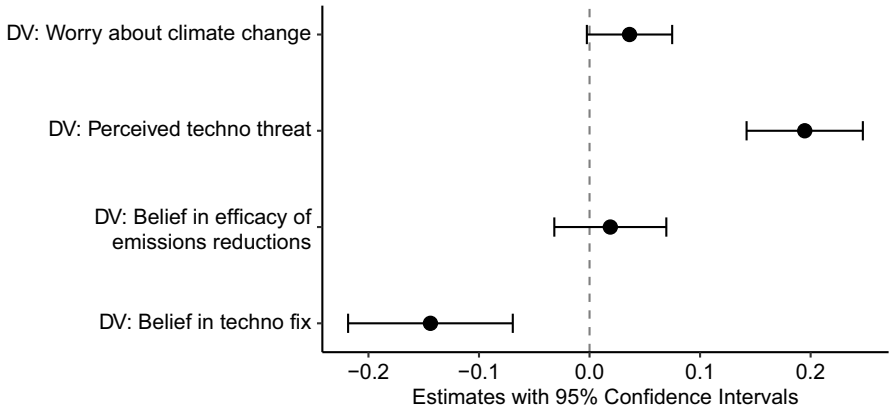

Figure 4. Effect of SAI information on other attitudes.

Effects of information on support for mitigation policy

Figure 2 reports the estimated effects of our information treatments on our index of support for emissions mitigation policy.[10] In model 1, we compare respondents who received SAI information (whether or not they also received the decarbonization information) to those who did not; in model 2, we compare respondents who received decarbonization information (whether or not they also received the SAI information) to those who did not; in model 3, we regress the outcome on the categorical treatment condition, thus comparing respondents across the four treatment conditions in our factorial experiment.

[10]Appendix Table 2 shows the corresponding regression table.

https://doi.org/10.1017/XPS.2025.10017 Published online by Cambridge University Press

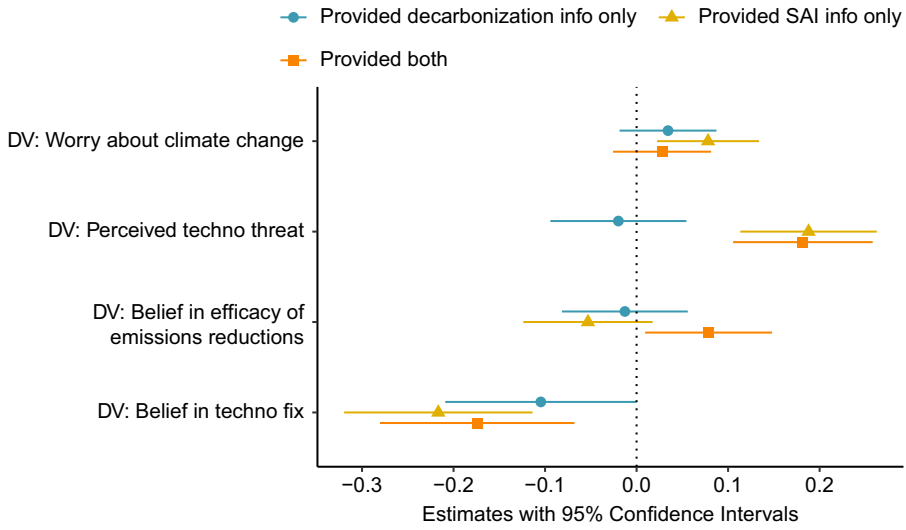

Figure 5. Effect of each information treatment on other attitudes.

All the point estimates are positive, but none of the effects are significant at the .05 level, and magnitudes are small: e.g., the point estimate in model 3 suggests that providing both SAI and decarbonization information increases support for mitigation policy by 0.053 standard deviations compared to no information ($p = 0.099$).

In the Appendix, we present an exploratory analysis assessing the effect of our information treatments on each of the policies in the index (Figure 5, Figure 6). We find significant positive effects of the decarbonization message and marginally significant effects of the SAI message on support for building nuclear power plants, as well as marginally significant positive effects of all messages on support for encouraging individuals to use less energy. Future confirmatory analysis could assess these effects.

Appendix Table 3 shows a version of the analysis in Figure 2 where we use raking to weight the sample to match population demographic margins.[11] As in the unweighted results, effects are null (though the point estimate of the effect of the SAI message is larger in the weighted sample).

Heterogeneous effects of SAI information on support for mitigation policy

Although SAI information did not significantly affect average support for mitigation policy (Figure 2), it may have larger effects in subgroups. Following our PAP, we assessed treatment effect heterogeneity by respondents' political ideology (prompted by Cherry et al. (2021)'s finding that SAI information increased carbon tax support among more egalitarian and communitarian respondents) and by respondents' concern about climate change and attribution of climate change to human causes (because we hypothesized that the "clarion call" effect would be larger for people who are initially more complacent about climate change). Figure 3 shows the results.

[11]This analysis was not in our PAP but was suggested by a reviewer.

https://doi.org/10.1017/XPS.2025.10017 Published online by Cambridge University Press

For respondents who self-identify (pre-treatment) as "Liberal" or "Very liberal," we cannot reject the null hypothesis that providing SAI information has no effect (model 1). In fact, the point estimate suggests that SAI information might have a slightly negative effect for liberals and a slightly positive effect for others (p-value on the main effect: 0.086; p-value on the difference: 0.059). This contrasts with Cherry et al. (2021), who find that SAI information encourages support for a carbon tax among more egalitarian and communitarian respondents (many of whom likely self-identify as liberals[12]) and not among others.

For respondents who say they are "Not concerned at all" or "Slightly concerned" about global warming (pre-treatment), SAI information appears to increase their average support for mitigation policy by about .12 SD, though the difference between this effect and the effect for other respondents is not statistically significant ($p = 0.051$).

Finally, for respondents in the bottom two quintiles in attributing global warming to human activity (pre-treatment), SAI information does not have a statistically significant effect on average support for mitigation policy, although the point estimate suggests that it slightly increases their average support. Again, the difference between this effect and the effect for other respondents is not statistically significant ($p = 0.055$).

Although none of the differences are statistically significant, the estimated effect of SAI information on support for emissions reductions is consistently more positive for the subgroup of respondents with lower average support for emissions reductions (non-liberals, those less concerned about climate change, and those who attribute less of climate change to human action).[13] This could reflect a ceiling effect: SAI information can only noticeably increase support for emissions reductions for people who are not already highly concerned about climate change and fully supportive of emissions reductions.

The appendix reports exploratory, non-preregistered analysis on other heterogeneous effects of SAI information. We find suggestive evidence that SAI information increases support for mitigation policy among older respondents and non-college graduates, though the relevant interaction terms are significant only at the .1 level (Table 7).

Effect of SAI information on other attitudes

Figure 4 shows the estimated effect of providing SAI information on other post-treatment outcomes designed to tap into possible mechanisms by which SAI information could affect policy preferences.

We estimate that exposure to SAI information (i) increases post-treatment worry about global warming (as measured by our index) by about 0.036 standard deviations, though we cannot reject the null ($p = 0.066$); (ii) increases respondents'

[12]According to Cherry et al. (2021), "those with egalitarian and communitarian views tend to see the market as a source of inequality and unjustness, and thus tend to readily accept descriptions of risk that imply that the market should be regulated."

[13]The regression results in Appendix Table 4 document these differences in level of support across subgroups.

https://doi.org/10.1017/XPS.2025.10017 Published online by Cambridge University Press

perception that without emissions reductions, addressing global warming may require "deploying unproven technologies with harmful consequences" ("perceived techno threat" in Figure 4) by about 0.195 standard deviations ($p < .001$); and (iii) decreases respondents' confidence that global warming can be addressed without "significantly reducing carbon dioxide emissions" ("belief in techno fix" in Figure 4) by about -0.144 standard deviations ($p < .001$). (The latter two effects are significant even after applying a Bonferroni correction as specified in our PAP.) Our SAI treatment thus appears to generally make respondents more pessimistic about climate change on average: slightly more worried about its effects (though this evidence is only suggestive), more concerned about measures that might be taken to address it, and more skeptical that the problem can be addressed without reducing emissions. We view this as evidence that balanced SAI information serves as an attitudinal "clarion call" for many respondents (Merk et al. 2016), even if average effects on emissions policy preferences are muted.

In Figure 5, we report the effect of each distinct information treatment (relative to control) on the same attitudes.[14] We highlight the most important findings.

Of the three treatments, only providing SAI information on its own significantly increases worry about climate change relative to control. Our SAI information in isolation may have especially worried respondents because it emphasizes that emissions reductions won't immediately cool the planet and/or because putting sulfuric acid in the atmosphere sounds risky. SAI information appears to worry respondents less when it is paired with a decarbonization message, though we cannot reject the null that the two effects are the same ($p = 0.077$).

Although above we found that providing SAI information has null average effects on belief in the efficacy of emissions reductions, Figure 5 shows that it matters whether decarbonization information is also included: the combined treatment made respondents believe in emissions reduction efficacy more (by .079 SDs), while the effect of SAI information on its own is negative (p value on difference in the two effects: 0.012).

The last set of estimates in Figure 5 shows that the decarbonization treatment, like the SAI treatment, reduced confidence in the existence of a "techno fix" that would obviate the need for emissions reductions (compared to control). The effect of the SAI treatment was larger, however ($p. = 0.036$). This suggests that a balanced message about SAI information could be even more effective than a decarbonization message at convincing people of the necessity of emissions reductions.

Discussion

Our study investigated how providing balanced information about SAI as a potential temporary response to climate change, both with and without a message about the importance of decarbonization, affects public support for decarbonization policies and related attitudes in the USA. We found no significant effects of SAI information on support for emissions mitigation policies on average, which contrasts both with previous research showing a moral hazard or crowding-out

[14]These analyses are pre-registered, but in our PAP we stated that we would treat them as exploratory given the multiple comparisons being made. The regression results appear in Appendix Table 6.

https://doi.org/10.1017/XPS.2025.10017 Published online by Cambridge University Press

effect (Raimi et al. 2019; Campbell-Arvai et al. 2017) and with previous research documenting a "clarion call" or crowding-in effect (Merk et al. 2016; Cherry et al. 2021). We did, however, find some evidence that SAI information increases support for mitigation among respondents more skeptical of climate change, and we found that information about SAI makes climate change appear to be a more serious problem, consistent with the "clarion call" hypothesis. Thus, our findings suggest that broader awareness of SAI will not reduce, and may even increase, support for decarbonization policy.

Our study also highlights the importance of balanced messaging that portrays SAI as a potentially risky complement to decarbonization rather than as a substitute. Our SAI treatment highlighted the technology's risks, which may explain why it increased worry about climate change while not eroding support for decarbonization. It also increased confidence that emissions reductions would mitigate future warming, but only when paired with a message emphasizing the importance of decarbonization. Future studies should further investigate this and other ways in which combinations of messages alter the public perception of climate change and responses to it.

Our study has important limitations, some of which future work can address. As in most research in this area (e.g., Cherry et al. 2021; Raimi et al. 2019; Fairbrother 2016), our outcome measures are simply stated positions in an online survey; following Merk et al. (2016) and Merk & Wagner (2024), future work could examine how similar information treatments affect "real stakes" outcomes such as willingness to donate or sign a petition. Moreover, as in other studies, our treatment is just a short text passage and an image. The effects of an actual program of SAI that alters the climate (and the discourse around climate change) could be altogether different.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/XPS.2025.10017.

Data availability. The data, code, and any additional materials required to replicate all analyses in this article are available at the Journal of Experimental Political Science Dataverse within the Harvard Dataverse Network, at: doi: https://doi.org/10.7910/DVN/3N2OPB.

Competing interests. The costs of running the survey were defrayed by support from the University of Chicago's Climate Systems Engineering Initiative (CSEi, $5,000) and by a University of Chicago Core Conversation Innovation Grant ($2,500).

Ethics statements. The University of Chicago's Social and Behavioral Sciences Institutional Review Board gave this research an exempt determination (IRB23-0386-AM003). The research adheres to APSA's Principles and Guidance for Human Subjects Research, as discussed in Section 3 of the online appendix.

References

Andrews, T. M., A. W. Delton, and R. Kline 2022. "Anticipating Moral Hazard Undermines Climate Mitigation in an Experimental Geoengineering Game." *Ecological Economics 196*: 107421.

Austin, M. M., and B. A. Converse, 2021. "In Search of Weakened Resolve: Does Climate-Engineering Awareness Decrease Individuals' Commitment to Mitigation?." *Journal of Environmental Psychology 78*: 101690.

Bergquist, P., J. R. Marlon, M. H. Goldberg, A. Gustafson, S. A. Rosenthal, and A. Leiserowitz 2022. "Information About the Human Causes of Global Warming Influences Causal Attribution, Concern, and Policy Support Related to Global Warming." *Thinking & Reasoning 28*(3): 465–86.

Campbell-Arvai, V., P. S. Hart, K. T. Raimi, and K. S. Wolske 2017. "The Influence of Learning about Carbon Dioxide Removal (CDR) on Support for Mitigation Policies." *Climatic Change 143*(3-4): 321–36.

Cherry, T. L., S. Kallbekken, S. Kroll, and D. M. McEvoy, 2021. "Does Solar Geoengineering Crowd out Climate Change Mitigation Efforts? Evidence from a Stated Preference Referendum on a Carbon Tax." *Climatic Change 165*: 1–8.

Eggers, A. 2025. "Replication Data for: Balanced messaging about solar geoengineering does not reduce average support for emissions reductions'. https://doi.org/10.7910/DVN/3N2OPB

Fairbrother, M. 2016. "Geoengineering, Moral Hazard, and Trust in Climate Science: Evidence from a Survey Experiment in Britain." *Climatic Change 139*(3): 477–89.

Hamilton, C. 2013. *Earthmasters: The Dawn of the Age of Climate Engineering*, Yale University Press.

Hart, P. S., V. Campbell-Arvai, K. S. Wolske, and K. T. Raimi 2022. "Moral Hazard or Not? The Effects of Learning about Carbon Dioxide Removal on Perceptions of Climate Mitigation in the United States." *Energy Research & Social Science 89*: 102656.

Keith, D. 2021. "What's the least bad way to cool the planet?." New York Times. https://www.nytimes.com/2021/10/01/opinion/climate-change-geoengineering.html

Keith, D. W. 2000. "Geoengineering the climate: History and prospect." *Annual review of energy and the environment 25*(1): 245–84.

Lin, A. C. 2013. "Does Geoengineering Present a Moral Hazard." *Ecology Law Quarterly 40*: 673.

Merk, C., G. Pönitzsch, and K. Rehdanz 2016. "Knowledge about Aerosol Injection does not Reduce Individual Mitigation Efforts." *Environmental Research Letters 11*(5): 054009.

Merk, C., and G. Wagner (2024. "Presenting Balanced Geoengineering Information has Little Effect on Mitigation Engagement." *Climatic Change 177*(1): 11.

Montgomery, J. M., B. Nyhan, and M. Torres 2018. "How Conditioning on Posttreatment Variables can Ruin your Experiment and What to do About it." *American Journal of Political Science 62*(3): 760–75.

National Academies of Sciences, Engineering, and Medicine 2021, *Reflecting Sunlight: Recommendations for Solar Geoengineering Research and Research Governance*, The National Academies Press.

Raimi, K. T., A. Maki, D. Dana, and M. P. Vandenbergh 2019. "Framing of Geoengineering Affects Support for Climate Change Mitigation." *Environmental Communication 13*(3): 300–19.

Reynolds, J. (2015. "A Critical Examination of the Climate Engineering Moral Hazard and Risk Compensation Concern." *The Anthropocene Review 2*(2): 174–91.

Schoenegger, P., and K. Mintz-Woo 2024. "Moral Hazards and Solar Radiation Management: Evidence from a Large-Scale Online Experiment." *Journal of Environmental Psychology 95*: 102288.

Sloot, D., and A. Bostrom 2024. "The Role of Framing in Public Support for Direct Air Capture: A Moral Hazard Survey Experiment in the United States." *Energy Research & Social Science 116*: 103694.

Sugiyama, M., S. Asayama, and T. Kosugi 2020. "The North-South Divide on Public Perceptions of Stratospheric Aerosol Geoengineering?: A Survey in Six Asia-Pacific Countries." *Environmental Communication 14*(5): 641–56.

Thompson, J. 2021. "Solar Geoengineering Could Become the "New Form of Denial" for Silicon Valley Enthusiasts, Critics Say." *Sierra: the magazine of the Sierra Club*. https://www.sierraclub.org/sierra/solar-geoengineering-could-become-new-form-denial-silicon-valley-enthusiasts-critics-say

Vasquez, K. 2021. "Solar geoengineering could wreak havoc on the planet." Sierra: the magazine of the Sierra Club. Publication date*: 2023-09-21*. https://www.sierraclub.org/sierra/2023-3-fall/stress-test/solar-geoengineering-could-wreak-havoc-planet

Wagner, G., and M. L. Weitzman 2015. *Climate Shock: The Economic Consequences of a Hotter Planet*. Princeton University Press.

Wenger, A., M. Stauffacher, and I. Dallo 2021. "Public Perception and Acceptance of Negative Emission Technologies–Framing Effects in Switzerland." *Climatic Change 167*(3): 53.

Cite this article: Antoan D, Chiang N, Dearman S, Espejel S, Fajors M, Huang D, Husseman E, Lavigne J, Lin I, Maheshwari N, Marinez Z, Nottley G, Perce J, Santos E, Sokhi N, Sole C, Tuchler A, Udinsky J, Li Z, and Eggers AC (2025). Balanced Messaging about Solar Geoengineering does not Reduce Average Support for Emissions Reductions. *Journal of Experimental Political Science*. https://doi.org/10.1017/XPS.2025.10017